INFANT, FETAL, NEONATAL AND PERINATAL MORTALITIES IN THE THREE MILE ISLAND AREA*

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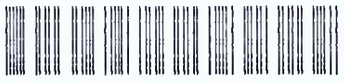

INFANT, FETAL, NEONATAL AND PERINATAL MORTALITIES IN THE THREE MILE ISLAND AREA

I. Introduction: The March 28, 1979 accident at the Three Mile Island (TMI) nuclear facility gave immediate rise to speculation about the impact it would have on pregnancy outcome. This was followed by an increasing demand for health data, particularly about infant mortality in the area. Some local residents attempted to obtain pregnancy outcome or infant death data before the data could be made available through official channels and prematurely released data obtained directly from local hospitals. These data were, more often than not, inaccurate, inappropriate, or misleading. We also noted that in-utero exposure to radiation has been reported to be associated with infant health and mortality (1-6). As a result, the Pennsylvania Department of Health conducted its own study of infant, fetal, neonatal and perinatal mortalities in the TMI area. Our study was based on vital statistics data compiled by the State Health Data Center.

II. Objective of the Study: The main objective of our study was to determine if the post-TMI levels and patterns of infant, fetal, neonatal and perinatal mortalities within the 10-mile area communities were significantly different from normal expectations based on the Statewide experiences. Post-TMI measures were also reviewed in comparison with pre-TMI measures.

III. Methods and Materials: The area under study included 35 communities all or part of which are within 10 miles of Three Mile Island.

Annual mortality data analyzed were those for the April 1970 through March 1986 period. This particular 12-month period within the study years was chosen because the TMI accident occurred in late March 1979. Quarterly (3-month period) analyses were done for shorter periods before and after the TMI accident.

The expected numbers of deaths for the study area in each of the 12-month intervals across the 16 year period were computed from the experiences of the State of Pennsylvania as a whole for comparable time periods. Statistical significance tests were based on the Poisson model (7). A standardized mortality ratio (SMR) i.e., observed/expected, was computed for each comparison.

Infant deaths are conventionally defined as the deaths of infants under one year of age. Those who die within 27 days of delivery are referred to as neonatal deaths. Fetal deaths analyzed in this study were stillbirths with at least 16-week gestation, but induced abortions were excluded. Also analyzed were perinatal mortality data which combined both fetal and neonatal deaths representing a more generalized measure of adverse pregnancy outcome.

IV. Results and Discussion: A. Infant Mortality: Table 1 shows observed and expected numbers of infant deaths for 12-month intervals from April 1970 through March 1986. The observed numbers of infant deaths for the area under study ranged from 33 to 89 during this 16-year period. None of these observed numbers were significantly different from the expected numbers.

Table 2 shows the observed and expected numbers of infant deaths according to quarter (3-months) for the period from April 1978 to March 1981. Quarterly data for these three years are presented because they are sufficient to show the variability of the data from quarter to quarter and the infant mortality in the two-year period immediately following the accident was considered to be indicative of potential influences of the TMI accident. The observed numbers of infant deaths during this period ranged from 5 to 21. These numbers indicate substantial variations by quarter. None of these observed numbers, however, were significantly different from the expected numbers except for the July-September quarter of 1978 when the observed number was significantly less than expected. The number of infant deaths during the 3-month period (April-June, 1979) immediately following the TMI accident was higher than expected, but the difference was not statistically significant.

B. Fetal Mortality: While much of the public concern about reproductive loss following the accident at TMI was focused on mortality among live-born infants, there was also considerable interest in fetal deaths. However, because a fetal death in Pennsylvania is required by law to be reported only when the gestational age of the fetus is 16 or more weeks, there are no routinely available data on fetuses which have not reached this minimum required gestational age for death registration. In addition to the unavailability of data on fetal deaths of less than 16 weeks gestation, there is evidence of underreporting at about sixteen weeks gestation.

Despite the limited utility of the available fetal mortality data as a measure of reproductive loss, it was considered to be of interest to analyze such data in conjunction with the infant mortality data. For purposes of this presentation, only annual fetal mortality data are discussed. Table 3 shows the numbers of fetal deaths (excluding abortions) for the TMI 10-mile area for the same 12-month intervals from 1970 through 1986.

The numbers of fetal deaths reported for the study area during the 16 April-March intervals shown in Table 3 ranged from 44 for the April 1981-March 1982 period to 85 for the April 1971-March 1972 period. There were 54 fetal deaths reported for the TMI area during the 12 months immediately following the accident. This was not significantly different from 52.4 expected. A statistically significant excess of fetal deaths was noted six years later.

C. Neonatal Mortality: Since infant deaths are heavily concentrated in the period immediately following delivery and these deaths are largely due to conditions which existed before delivery or to the birth process itself, it was important to closely examine neonatal deaths. The study of neonatal deaths during the first few months immediately following the TMI accident was particularly relevant because of the potential impact of the accident upon the most vulnerable period of early life.

As shown in Table 4, the observed numbers of neonatal deaths in the 10-mile area were not significantly different from the expected numbers throughout the 16-year period from 1970 to 1986. For the April

1979-March 1980 period immediately following the accident, the observed mortality pattern was no exception.

D. Perinatal Mortality: The concept of perinatal mortality provides a means for combining in-utero deaths with loss in early infancy, and thus can provide a more generalized risk of adverse pregnancy outcome. This measure also helps minimize certain of the inaccuracies which arise because of the poor reliability of reporting when the fetus is near or below the borderline of viability. In this study, perinatal deaths include fetal deaths of 16 or more weeks of gestation and infant deaths occurring within the first 27 days of life.

As shown in Table 5, the Standardized Mortality Ratios (SMRs) for the 12 months immediately following the accident at TMI were essentially the same as for the 12 months immediately prior to the accident and for the second year after the accident. None of these differences were statistically significant. Furthermore, no statistically significant differences were noted between observed and expected numbers for any of other 12-month periods from 1970 through 1986.

D. Limitations of Infant Mortality Statistics: The infant death rate, as usually computed, is a substitute for an age-specific rate intended to measure the risk of dying during the first year of life. If it were an age-specific rate, it would be the ratio of infant deaths to the infant population at risk (of dying) throughout the year following birth. However, the infant death rate is conventionally defined as the ratio of infant deaths in a given period to recorded live births for the

same period. Thus, the deaths under one year of age during any calendar year are not only of infants born that year but also of infants born the previous year.

A more accurate method of computing infant mortality risk is to relate infant deaths to corresponding births for given time periods. There is, however, a problem with respect to our ability to routinely follow a cohort for an entire year. For example, if a mother had been a resident of the TMI 10-mile area at the time of delivery and moved outside the area prior to the death of her baby, the baby might not be included in the study because specific information on place of residence at birth may not be recorded on the death certificate. While birth and death certificates of infants are routinely matched, this process does not always produce complete results. This is one reason why the TMI Mother/Child Registry with its aggressive follow-up program was established.

E. Birth Cohort and Infant Deaths: Table 6 compares the numbers of infant deaths in two 12-month birth cohorts immediately preceding the accident at TMI with those in two birth cohorts subsequent to the accident. These data are shown for the entire study area, for Harrisburg City, and for the balance of the area. In general, there is nothing in the birth cohort-based infant death rates to indicate a difference in the conclusions drawn on the basis of conventionally computed rates. The infant death rate for the cohort born in the 12-month period immediately following the accident was higher, but not significantly, than for the two previous 12-month cohorts. This increase, however, was largely due

to increases for the Harrisburg City-based cohorts. The rates for the remainder of the area did not change markedly. The results of these analyses suggest that the risk of infant mortality did not change significantly from the pre-TMI to the post-TMI years.

In order to further evaluate the potential effects of the TMI accident upon infant mortality, birth-cohort data for areas within 5 miles of TMI and areas within 5-10 miles of TMI were analyzed separately. Because minor civil divisions do not conveniently lie within specified radii of a given point, a community was included in an area if any part of it lay within the boundary of the area. The rates for the 5 and 5-10 mile areas were generally similar to those for the entire 10-mile area already described.

F. Conclusions: The results of a series of comprehensive analyses of the vital statistics data obtained from the State Health Data Center, indicate that the levels of post-TMI fetal, neonatal, perinatal or infant mortalities in the vicinity of the TMI nuclear facility were neither significantly higher than expected nor significantly different from the pre-TMI years. There is no clear evidence that the 1979 nuclear accident impacted significantly on the risk of late in-utero mortality or mortality during infancy; if there was an impact, it may have been too small to be detectable by the methods used in the present study.

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TABLE 1: Observed and Expected Numbers of Infant Deaths[1]: TMI 10-Mile Area, April 1970 - March 1986

Time Period: (Month/Year)	Infant Deaths Observed	Expected	SMR
4/70 - 3/71	89	93.0	0.96
4/71 - 3/72	85	80.8	1.05
4/72 - 3/73	63	71.7	0.88
4/73 - 3/74	57	63.8	0.89
4/74 - 3/75	59	62.9	0.94
4/75 - 3/76	69	57.2	1.21
4/76 - 3/77	53	55.2	0.96
4/77 - 3/78	47	52.4	0.90
4/78 - 3/79	46	50.2	0.92
4/79 - 3/80	61	52.2	1.17
4/80 - 3/81	56	52.7	1.06
4/81 - 3/82	55	49.4	1.11
4/82 - 3/83	59	48.0	1.23
4/83 - 3/84	46	43.3	1.06
4/84 - 3/85	33	43.2	0.76
4/85 - 3/86	40	43.7	0.92

[1] Resident infant deaths within one year of age.

STANDARDIZED MORTALITY RATIOS:
INFANT DEATHS IN THE TMI TEN-MILE AREA,
APRIL, 1970 - MARCH, 1986.

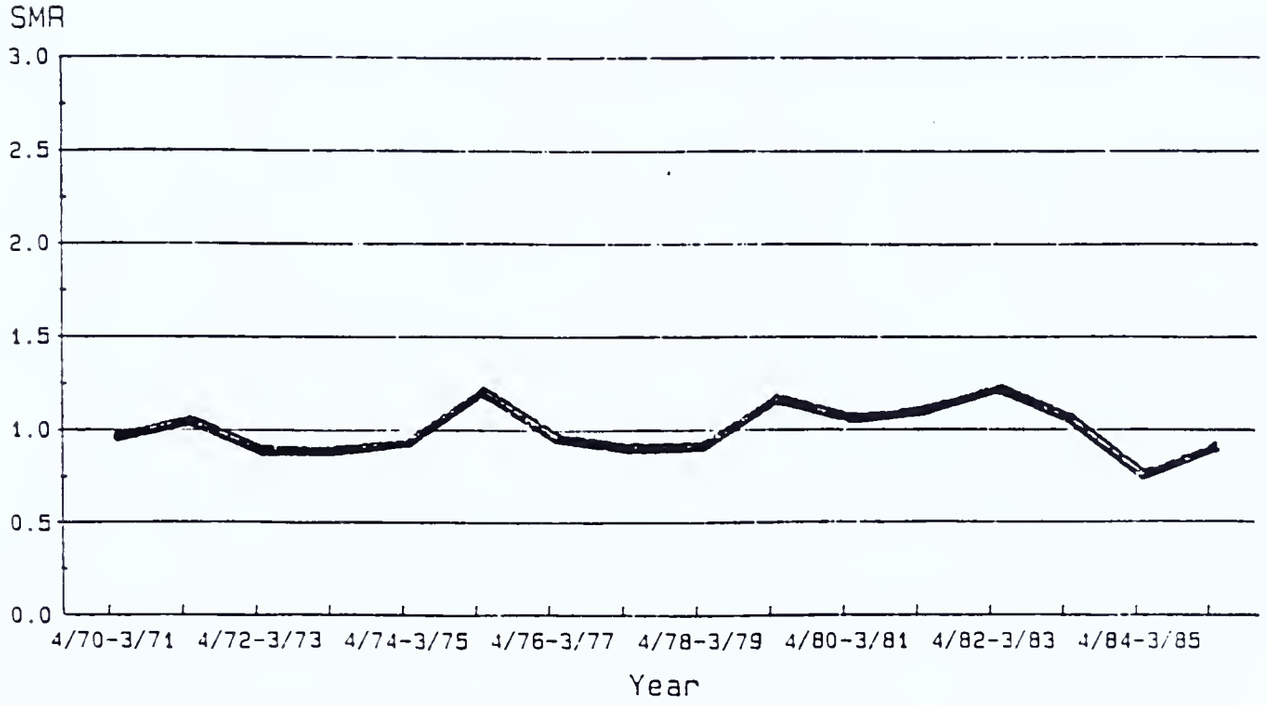

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TABLE 2: Observed and Expected Numbers of Infant Deaths[1] by Quarter: TMI 10-Mile Area, April 1978 - March 1979, April 1979 - March 1980, and April 1980 - March 1981

Time Period: Quarter	Including Harrisburg City		
	Observed	Expected	SMR
April 1978 - March 1979:			
April - June	9	12.9	0.70
July - September	5	12.2	0.41*
October - December	14	12.6	1.11
January - March	18	12.4	1.45
April 1979 - March 1980:			
April - June	19	13.8	1.38
July - September	13	12.4	1.05
October - December	13	13.9	0.94
January - March	16	12.1	1.32
April 1980 - March 1981:			
April - June	12	12.5	0.96
July - September	14	14.7	0.95
October - December	21	13.9	1.51
January - March	9	11.5	0.78

[1] Resident infant deaths within one year of age.
*Statistically significant at the 0.05 level

TABLE 3: Observed and Expected Numbers of Fetal Deaths[1]: TMI 10 Mile-Area, April 1970 - March 1986

Time Period: (Month/Year)	Fetal Deaths Observed	Expected	SMR
4/70 - 3/71	68	82.3	0.83
4/71 - 3/72	85	75.6	1.12
4/72 - 3/73	60	64.8	0.93
4/73 - 3/74	66	59.9	1.10
4/74 - 3/75	47	52.6	0.89
4/75 - 3/76	59	49.2	1.20
4/76 - 3/77	50	50.2	1.00
4/77 - 3/78	59	49.3	1.20
4/78 - 3/79	66	53.5	1.23
4/79 - 3/80	54	52.4	1.03
4/80 - 3/81	49	49.3	0.99
4/81 - 3/82	44	48.7	0.90
4/82 - 3/83	51	50.4	1.01
4/83 - 3/84	54	49.3	1.10
4/84 - 3/85	55	46.6	1.18
4/85 - 3/86	62	46.8	1.32*

1) Resident fetal deaths excluding abortions.
*Statistically significant at the 0.05 level

STANDARDIZED MORTALITY RATIOS:
FETAL DEATHS IN THE TMI TEN-MILE AREA,
APRIL, 1970 - MARCH, 1986.

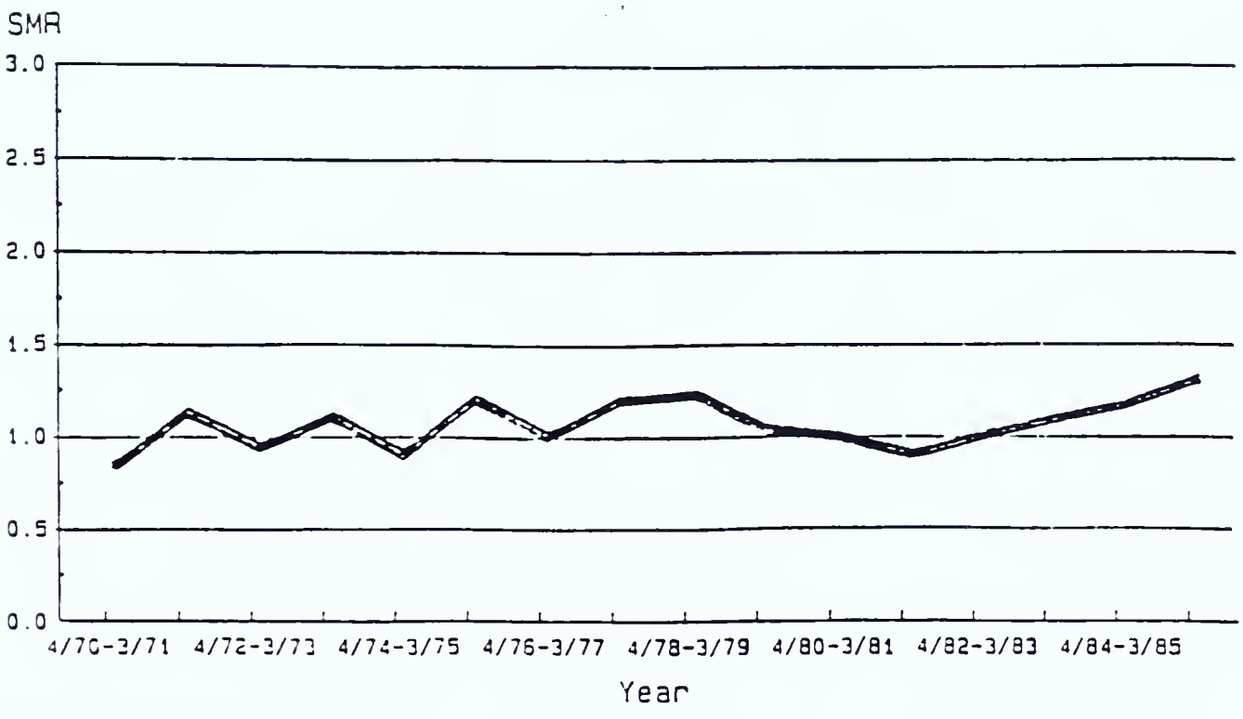

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TABLE 4: Observed and Expected Numbers of Neonatal Deaths[1]: TMI 10-Mile Area, April 1970 - March 1986

Time Period: (Month/Year)	Neonatal Deaths Observed	Expected	SMR
4/70 - 3/71	68	73.1	0.93
4/71 - 3/72	62	61.7	1.00
4/72 - 3/73	49	55.1	0.89
4/73 - 3/74	38	48.9	0.78
4/74 - 3/75	44	49.0	0.90
4/75 - 3/76	48	44.1	1.09
4/76 - 3/77	45	42.1	1.07
4/77 - 3/78	32	39.0	0.82
4/78 - 3/79	34	38.2	0.89
4/79 - 3/80	46	38.7	1.19
4/80 - 3/81	45	37.6	1.20
4/81 - 3/82	42	35.9	1.17
4/82 - 3/83	43	33.1	1.30
4/83 - 3/84	28	30.4	0.92
4/84 - 3/85	25	29.8	0.84
4/85 - 3/86	28	29.7	0.94

1) Resident neonatal deaths within 27 days of delivery.

STANDARDIZED MORTALITY RATIOS:
NEONATAL DEATHS IN THE TMI TEN-MILE AREA,
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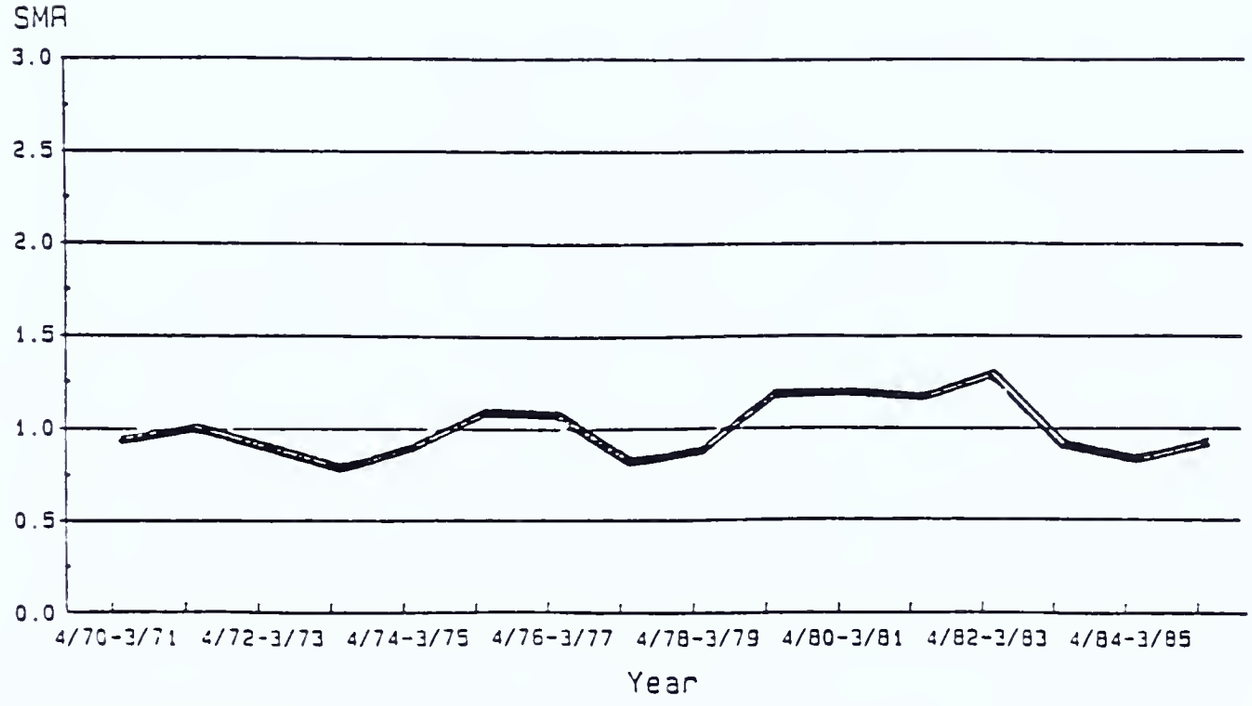

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TABLE 5: Observed and Expected Numbers of Perinatal Deaths[1]:

Time Period: (Month/Year)	Perinatal Deaths Observed	Expected	SMR
4/70 - 3/71	136	155.1	0.88
4/71 - 3/72	147	137.4	1.07
4/72 - 3/73	109	119.3	0.91
4/73 - 3/74	104	108.8	0.96
4/74 - 3/75	91	101.5	0.90
4/75 - 3/76	107	93.4	1.15
4/76 - 3/77	92	92.2	1.00
4/77 - 3/78	91	88.4	1.03
4/78 - 3/79	100	91.9	1.09
4/79 - 3/80	100	91.2	1.10
4/80 - 3/81	94	86.9	1.08
4/81 - 3/82	86	84.5	1.02
4/82 - 3/83	94	83.5	1.13
4/83 - 3/84	82	79.7	1.03
4/84 - 3/85	80	76.5	1.05
4/85 - 3/86	90	76.5	1.18

[1] Resident fetal and neonatal deaths combined.

STANDARDIZED MORTALITY RATIOS:
PERINATAL DEATHS IN THE TMI TEN-MILE AREA,
APRIL, 1970 - MARCH, 1986.

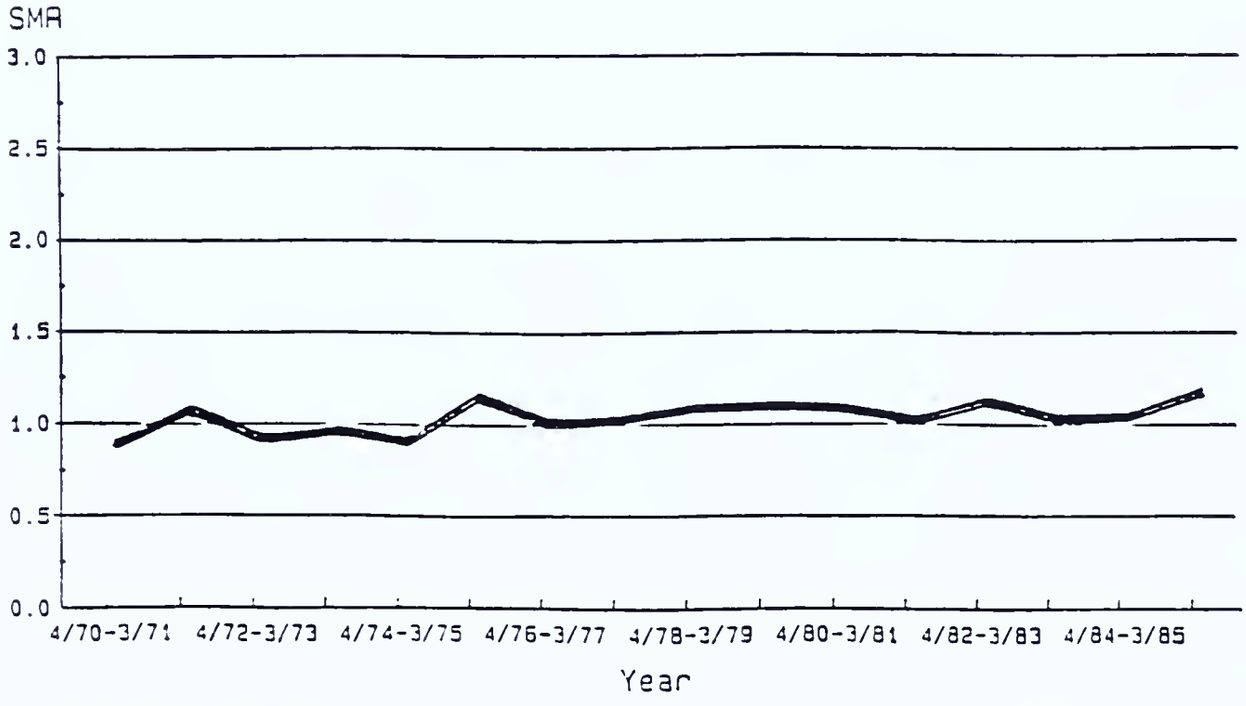

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TABLE 6: Number and Rate of Infant Deaths
Based on Birth Cohorts for the TMI Ten-Mile Area

Time Period and Birth Cohort	Live Births in Cohort	Infant Deaths	
		Numbers in Cohort[1]	Rate for Cohort[2]
		Total Area	
Pre-TMI	7,599	86	11.3
April 1977 - March 1978	3,790	43	11.3
April 1978 - March 1979	3,809	43	11.3
Post-TMI	7,989	104	13.0
April 1979 - March 1980	3,967	55	13.9
April 1980 - March 1981	4,022	49	12.2
		Harrisburg City	
Pre-TMI	2,112	33	15.6
April 1977 - March 1978	1,020	15	14.7
April 1978 - March 1979	1,092	18	16.5
Post-TMI	2,201	44	20.0
April 1979 - March 1980	1,162	26	22.4
April 1980 - March 1981	1,039	18	17.3
		Balance of Area	
Pre-TMI	5,487	53	9.7
April 1977 - March 1978	2,770	28	10.1
April 1978 - March 1979	2,717	25	9.2
Post-TMI	5,788	60	10.4
April 1979 - March 1980	2,805	29	10.3
April 1980 - March 1981	2,983	31	10.4

Notes: [1] Deaths within one year of life among infants born in a given 12-month period regardless of year of death.
[2] Infant death rates per 1,000 live births.